

## CLAIMS

- 1 1. A closed ink supply system wherein air is sealed outside the system and not  
2 allowed to flow into components of the system, the system comprising:  
3 (1) an ink source;  
4 (2) a first ink sub-reservoir comprising:  
5 (a) a first top fluid surface at a first sub-reservoir fluid height;  
6 (b) a first sub-reservoir ink inlet fluidly connected to the ink source;  
7 and  
8 (c) a first sub-reservoir outlet and a second sub-reservoir outlet that is  
9 above the first sub-reservoir outlet;  
10 (3) a print head comprising:  
11 (a) a first print head portion fluidly connected to the first sub-reservoir  
12 outlet; and  
13 (b) a second print head portion fluidly connected to the second sub-  
14 reservoir outlet, the second print head portion being above the  
15 first print head portion, whereby a first pressure at the first  
16 print head portion is substantially equal to a second pressure at  
17 the second print head portion.
- 1 2. The ink supply system of claim 1 further comprising:  
2 (4) a valve system fluidly connected between the ink source and the first sub-  
3 reservoir ink inlet;  
4 (5) an actuator system connected to the valve system; and  
5 (6) a first sensor connected to the actuator system, wherein the first sensor  
6 senses the first sub-reservoir fluid height, such that if the first sub-  
7 reservoir fluid height is below a first height range, the first sensor  
8 emits a signal to the actuator system, whereby the actuator system  
9 actuates the valve system, allowing ink to flow from the ink source to  
10 the first sub-reservoir ink inlet, and if the first sub-reservoir fluid  
11 height is above the first height range, the first sensor emits a signal to  
12 the actuator system, whereby the actuator system actuates the valve  
13 system, preventing ink from flowing from the ink source to the first  
14 sub-reservoir ink inlet.
- 1 3. The ink supply system of claim 2, wherein the actuator system comprises a  
2 first actuator connected to the first sensor, and wherein the valve system  
3 comprises a first valve connected to the first actuator.

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- 1 4. The ink supply system of claim 1, wherein the ink source comprises a main  
2 reservoir, and wherein a fluid connection between the first sub-reservoir ink  
3 inlet and the ink source comprises a gravity-fed conduit extending from the  
4 ink source to the first sub-reservoir ink inlet.
- 1 5. The ink supply system of claim 1, wherein the first sub-reservoir ink inlet is  
2 located at an upper portion of the first sub-reservoir, and wherein the first sub-  
3 reservoir outlet and the second sub-reservoir outlet are located at a lower  
4 portion of the first sub-reservoir.
- 1 6. The ink supply system of claim 1, wherein the first ink sub-reservoir is  
2 adjustable in height.
- 1 7. The ink supply system of claim 1 further comprising:  
2 (4) a pressure source; and  
3 wherein the first ink sub-reservoir further comprises:  
4 (d) a first sub-reservoir pressure inlet fluidly connected to the pressure  
5 source.
- 1 8. The ink supply system of claim 1 further comprising:  
2 (4) a second ink sub-reservoir comprising:  
3 (a) a second top fluid surface at a second sub-reservoir fluid height  
4 that is above the first sub-reservoir fluid height;  
5 (b) a second sub-reservoir ink inlet fluidly connected to the ink  
6 source; and  
7 (c) a third sub-reservoir outlet and a fourth sub-reservoir outlet that is  
8 above the third sub-reservoir outlet; and  
9 wherein the print head further comprises:  
10 (c) a third print head portion fluidly connected to the third sub-  
11 reservoir outlet; and  
12 (d) a fourth print head portion fluidly connected to the fourth sub-  
13 reservoir outlet, the fourth print head portion being above the  
14 third print head portion and the third print head portion being  
15 above the second print head portion, whereby a third pressure  
16 at the third print head portion and a fourth pressure at the  
17 fourth print head portion are substantially equal to the first  
18 pressure at the first print head portion and the second pressure  
19 at the second print head portion.

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- 1 9. The ink supply system of claim 8 further comprising:  
2 (5) a valve system fluidly connected between the ink source and the first sub-  
3 reservoir ink inlet and the second sub-reservoir ink inlet;  
4 (6) an actuator system connected to the valve system;  
5 (7) a first sensor connected to the actuator system, wherein the first sensor  
6 senses the first sub-reservoir fluid height, such that if the first sub-  
7 reservoir fluid height is below a first height range, the first sensor  
8 emits a signal to the actuator system, whereby the actuator system  
9 actuates the valve system, allowing ink to flow from the ink source to  
10 the first sub-reservoir ink inlet, and if the first sub-reservoir fluid  
11 height is above the first height range, the first sensor emits a signal to  
12 the actuator system, whereby the actuator system actuates the valve  
13 system, preventing ink from flowing from the ink source to the first  
14 sub-reservoir ink inlet; and  
15 (8) a second sensor connected to the actuator system, wherein the second  
16 sensor senses the second sub-reservoir fluid height, such that if the  
17 second sub-reservoir fluid height is below a second height range, the  
18 second sensor emits a signal to the actuator system, whereby the  
19 actuator system actuates the valve system, allowing ink to flow from  
20 the ink source to the second sub-reservoir ink inlet, and if the second  
21 sub-reservoir fluid height is above the second height range, the second  
22 sensor emits a signal to the actuator system, whereby the actuator  
23 system actuates the valve system, preventing ink from flowing from  
24 the ink source to the second sub-reservoir ink inlet.
- 1 10. The ink supply system of claim 9, wherein the actuator system comprises a  
2 first actuator connected to the first sensor and a second actuator connected to  
3 the second sensor, and wherein the valve system comprises a first valve  
4 connected to the first actuator and a second valve connected to the second  
5 actuator.
- 1 11. The ink supply system of claim 8, wherein the ink source comprises a main  
2 reservoir, and wherein fluid connections between the first sub-reservoir ink  
3 inlet and the ink source and the second sub-reservoir ink inlet and the ink  
4 source comprise gravity-fed conduits extending from the ink source to the  
5 first sub-reservoir ink inlet and the ink source to the second sub-reservoir ink  
6 inlet respectively.

1 12. The ink supply system of claim 8, wherein the first sub-reservoir ink inlet is  
2 located at an upper portion of the first sub-reservoir, wherein the first sub-  
3 reservoir outlet and the second sub-reservoir outlet are located at a lower  
4 portion of the first sub-reservoir; wherein the second sub-reservoir ink inlet is  
5 located at an upper portion of the second sub-reservoir, and wherein the third  
6 sub-reservoir outlet and the fourth sub-reservoir outlet are located at a lower  
7 portion of the second sub-reservoir.

1 13. The ink supply system of claim 8, wherein the first ink sub-reservoir and the  
2 second ink sub-reservoir are adjustable in height.

1 14. The ink supply system of claim 8 further comprising:  
2 (4) a pressure source;  
3 wherein the first ink sub-reservoir further comprises:  
4 (d) a first sub-reservoir pressure inlet fluidly connected to the pressure  
5 source; and  
6 wherein the second ink sub-reservoir further comprises:  
7 (d) a second sub-reservoir pressure inlet fluidly connected to the  
8 pressure source.

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1 15. A closed ink supply system wherein air is sealed outside the system and not  
2 allowed to flow into components of the system, the system comprising:  
3 (1) a main reservoir;  
4 (2) a pressure source;  
5 (3) a first ink sub-reservoir comprising:  
6 (a) a first top fluid surface at a first sub-reservoir fluid height;  
7 (b) a first sub-reservoir ink inlet fluidly connected to the main  
8 reservoir;  
9 (c) a first sub-reservoir pressure inlet fluidly connected to the pressure  
10 source; and  
11 (d) a first sub-reservoir outlet and a second sub-reservoir outlet that is  
12 above the first sub-reservoir outlet;  
13 (4) a second ink sub-reservoir comprising:  
14 (a) a second top fluid surface at a second sub-reservoir fluid height  
15 that is above the first sub-reservoir fluid height;  
16 (b) a second sub-reservoir ink inlet fluidly connected to the main  
17 reservoir;  
18 (c) a second sub-reservoir pressure inlet fluidly connected to the  
19 pressure source; and  
20 (d) a third sub-reservoir outlet and a fourth sub-reservoir outlet that is  
21 above the third sub-reservoir outlet;  
22 (5) a valve system fluidly connected between the main reservoir and the first  
23 sub-reservoir ink inlet and the second sub-reservoir ink inlet;  
24 (6) an actuator system connected to the valve system;  
25 (7) a first sensor connected to the actuator system, wherein the first sensor  
26 senses the first sub-reservoir fluid height, such that if the first sub-  
27 reservoir fluid height is below a first height range, the first sensor  
28 emits a signal to the actuator system, whereby the actuator system  
29 actuates the valve system, allowing ink to flow from the main  
30 reservoir to the first sub-reservoir ink inlet, and if the first sub-  
31 reservoir fluid height is above the first height range, the first sensor  
32 emits a signal to the actuator system, whereby the actuator system  
33 actuates the valve system, preventing ink from flowing from the main  
34 reservoir to the first sub-reservoir ink inlet;  
35 (8) a second sensor connected to the actuator system, wherein the second  
36 sensor senses the second sub-reservoir fluid height, such that if the  
37 second sub-reservoir fluid height is below a second height range, the  
38 second sensor emits a signal to the actuator system, whereby the  
39 actuator system actuates the valve system, allowing ink to flow from  
40 the main reservoir to the second sub-reservoir ink inlet, and if the  
41 second sub-reservoir fluid height is above the second height range, the  
42 second sensor emits a signal to the actuator system, whereby the  
43 actuator system actuates the valve system, preventing ink from

44 flowing from the main reservoir to the second sub-reservoir ink inlet;  
45 and  
46 (9) a print head comprising:  
47 (a) a first print head portion fluidly connected to the first sub-reservoir  
48 outlet;  
49 (b) a second print head portion fluidly connected to the second sub-  
50 reservoir outlet;  
51 (c) a third print head portion fluidly connected to the third sub-  
52 reservoir outlet; and  
53 (d) a fourth print head portion fluidly connected to the fourth sub-  
54 reservoir outlet, the fourth print head portion being above the  
55 third print head portion, the third print head portion being  
56 above the second print head portion, and the second print head  
57 portion being above the first print head portion, whereby a first  
58 pressure at the first print head portion, a second pressure at the  
59 second print head portion, a third pressure at the third print  
60 head portion, and a fourth pressure at the fourth print head  
61 portion are substantially equal to one another.

1 16. A method of supplying ink to a print head through a closed ink supply system  
2 wherein air is sealed outside the system and not allowed to flow into  
3 components of the system, the method comprising the steps of:  
4 (1) supplying ink from a first ink sub-reservoir to a first print head portion  
5 fluidly connected to a first sub-reservoir outlet of the first ink sub-  
6 reservoir;  
7 (2) supplying ink from the first ink sub-reservoir to a second print head  
8 portion above the first print head portion fluidly connected to a second  
9 sub-reservoir outlet above the first sub-reservoir outlet of the first ink  
10 sub-reservoir, whereby a first pressure at the first print head portion is  
11 substantially equal to a second pressure at the second print head  
12 portion;  
13 (3) sensing a first sub-reservoir fluid height;  
14 (4) supplying ink to the first ink sub-reservoir if the first sub-reservoir fluid  
15 height is below a first height range; and  
16 (5) ceasing supplying ink to the first ink sub-reservoir if the first sub-  
17 reservoir fluid height is above the first height range.  
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- 1 17. The method of claim 16, further comprising the steps of:  
2 (6) supplying ink from a second ink sub-reservoir to a third print head portion  
3 above the second print head portion fluidly connected to a third sub-  
4 reservoir outlet of the second ink sub-reservoir;  
5 (7) supplying ink from the second ink sub-reservoir to a fourth print head  
6 portion above the third print head portion fluidly connected to a fourth  
7 sub-reservoir outlet above the third sub-reservoir outlet of the second  
8 ink sub-reservoir, whereby a third pressure at the third print head  
9 portion is substantially equal to a fourth pressure at the fourth print  
10 head portion;  
11 (8) sensing a second sub-reservoir fluid height above the first sub-reservoir  
12 fluid height;  
13 (9) supplying ink to the second ink sub-reservoir if the second sub-reservoir  
14 fluid height is below a second height range; and  
15 (10) ceasing supplying ink to the second ink sub-reservoir if the second sub-  
16 reservoir fluid height is above the second height range.
- 1 18. The method of claim 16, wherein the step of supplying ink to the first ink sub-  
2 reservoir comprises using gravity to feed ink through a conduit that extends  
3 from an ink source to the first ink sub-reservoir.
- 1 19. The method of claim 16, wherein the step of supplying ink to the first ink sub-  
2 reservoir comprises actuating a valve system, and wherein the step of ceasing  
3 supplying ink to the first ink sub-reservoir comprises actuating the valve  
4 system.
- 1 20. The method of claim 16 further comprising the step of:  
2 (6) adjusting a height of the first ink sub-reservoir.

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